

## **LESSONS LEARNED FROM GEOTHERMAL DEVELOPMENT IN GUATEMALA**

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### **ABSTRACT**

During 2005 Guatemala total installed capacity was 2,087.7 MW and its energy demand 1,290.1 MW. It is mostly provided by fossil fuels 65% and 35 % are provided by renewable (hydropower and geothermal). From this 35 %, only 2% comes from geothermal production. The geothermal production started in 1998. Actually there are two geothermal plants in operation and they provide 33 MW of the total energy production, and it is estimated to be on line at the end of this year, Ortitlán geothermal plant that will provide 22MW. The geothermal resources in Guatemala are estimated at 800 to 4,000 MW capacity, most likely 1,000 MW (Lippman, 2002); it is the one Central American country with least geothermal installed capacity of the countries with geothermal production (Costa Rica, El Salvador and Nicaragua). 13 geothermal fields have been identified, 6 of them Zunil I, Zunil II, Amatitlán, San Marcos, Tecuamburro and Moyuta have an estimated potential of 430 MW. The Government has been promoting the exploitation of the renewable resources and a law of incentives has been promoted as well as a structured communication strategy to attain public acceptance for the future developing projects and to have interested private energy developers to join this development. Initiatives have been realized to continue the support of the geothermal development, focusing in Zunil II and Tecuamburro geothermal field.

### **1. INTRODUCTION**

The exploration of the geothermal resources started in the 70's and this function was seen as part of the government's overall responsibilities to develop the natural resources to meet the needs of its people. As a result of this exploration an inventory of 13 geothermal fields with an estimated potential is known (Figure 1). The State developer through Instituto Nacional de Electrificación –INDE– have been in charge of the prefeasibility and feasibility studies of the fields that at reached that stage, financed with its own funds and international financial grants technical cooperation and loans from IADB, JICA(OTCA), OLADE, IAEA, USAID, ROCAP, etc.



The fields developed are Amatitlán (started operation 1998), actually is operating a 5 MW backpressure turbine and at the end of this year it is expected to be on line with 22 MW. Zunil I (started operation 1999) it installed capacity provides 28 MW. In comparison with the other Central American countries, Guatemala has 33 MW installed (Table 1).

TABLE 1

<b>Central American Region: Electric Statistics, 2005</b>								
<b>National Interconnected systems</b>								
<b>Concept</b>	<b>Unit</b>	<b>Region</b>	<b>Costa Rica</b>	<b>El Salvador</b>	<b>Guatemala</b>	<b>Honduras</b>	<b>Nicaragua</b>	<b>Panama</b>
<b>Installed Capacity</b>	<b>MW</b>	<b>9,063.5</b>	<b>1,961.2</b>	<b>1,231.8</b>	<b>2,087.7</b>	<b>1,450.4</b>	<b>757.2</b>	<b>1,575.2</b>
<b>Hydroelectric</b>	"	3,878.8	1,303.6	460.9	699.8	478.1	104.4	832.0
<b>Geothermal</b>	"	427.4	165.7	151.2	33.0	-	77.5	-
<b>Thermal</b>	"	4,688.7	423.3	619.7	1,354.9	972.3	575.3	743.3
<b>Eolic</b>	"	68.6	68.6	-	-	-	-	-

Source: Cepal Statistics 2005

## 2. PRIVATE ENERGY DEVELOPMENT

The trend toward globalization by international power and energy companies has led the geothermal power production to change the scheme, adjust the activities to the legal regulatory framework and try to be competitive in the electricity market. On November 15, 1996, the Congress of the Republic of Guatemala passed the General Electricity Law with the purpose of establishing the main norms for the development of transmission, commercialisation, distribution and generation activities in the electricity sector. Subsequently, on March 21, 1997, the Ministry of Energy and Mines issued the Regulations for the General Electricity Law. The objective of this new regulation can be summarised in the following points:

- That the electricity industry be developed in an open and competitive environment where it is possible to have prices which reflect cost-efficiency;
- That electricity service to customers is provided under good quality conditions and that customers can benefit from prices resulting from a competitive market; and
- That the electricity industry in Guatemala is able to integrate itself within the Central American regional market.

Generation and commercialisation activities are organised in an electricity wholesale market giving open access to new participants and open frontiers for wholesale markets of other countries. Income generation through imports benefits the market by increasing competition and ensuring supply for end users. In turn, the opportunity to export generation surpluses increases the size of the market to which domestic generators have access. In this way, an open-border regime increases market size and permits taking advantage of better prices within the region. It also gives access to other countries' surpluses and increases the utilisation factor of installed capacity through sales to other countries.

The country deregulated its electricity sector, allowing private industry to participate in the business of power generation. In the case of geothermal development the private participation has been through concession arrangements, initiated after the project had reached the plant construction stage. These

have been the case for Orzunil and Ortitlán geothermal plants, both have signed concession contracts and it also includes Power Purchase Agreement (take or pay) with INDE.

INDE as another agent in the electricity market represents the public sector (State) and it has the responsibility to sustain and finance the social tariff, that is state subsidy to the electricity consumers. This is possible due to renewable resources production that represents the load base of the daily economic dispatch of generation sources; in this order the energy bought during the last five years (Tables 2 and 3) represents the lowest prices in the wholesale market and it represent a need to be improve to sustain low prices of electricity for the population. Figure 3 shows the evolution of average prices over the last five years.

TABLE 2

<b>EVOLUTION OF AVERAGE ENERGY PRICE BY CONTRACTS AT TERM</b>					
<b>Bought energy GWh</b>					
<b>Cogenerators</b>		<b>Autoproducers and independent producers</b>			
		<b>Thermal</b>	<b>Hydro</b>	<b>Geo</b>	<b>Coal</b>
2000	649.184	692.240	182.592	184.153	509.37
2001	578.85	740.959	100.212	123.213	843.334
2002	594.539	848.510	215.389	130.034	905.626
2003	590.695	993.886	250.429	162.330	842.465
2004	729.04	1816.752	275.56	160.040	914.737
2005	729.04		231.652	166.240	

TABLE 3

<b>Price (US\$/kWh)</b>					
<b>Autoproducers and independent producers</b>					
	<b>Cogenerators</b>	<b>Thermal</b>	<b>Hydro</b>	<b>Geo</b>	<b>Coal</b>
2000	0.085	0.174	0.065	0.058	0.131
2001	0.095	0.117	0.066	0.057	0.071
2002	0.091	0.111	0.068	0.088	0.071
2003	0.114	0.112			0.076
2004	0.091	0.081	0.063	0.076	0.076
2005			0.073	0.065	

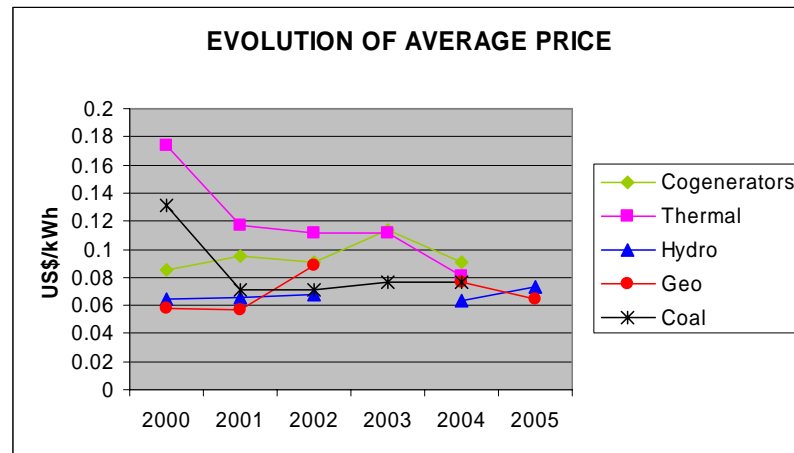


FIGURE 3

Source: Cepal Statistics 2005

### 3. GOVERNMENT DECISION TO SUPPORT RENEWABLES

To promote the use of renewable resources in Guatemala a law of incentives has been promoted to encourage private investors to develop the resources including the geothermal. Guatemala has renewable resources that could be useful to the country and their use will give the country independence from buying the fossil fuels, providing at the same time economic energy supply that favour the final consumers to the Guatemalan and the Central American population. At the same time this law encourages the environmental quality and the participation of renewable energy investors. The law was promulgated on November 2003 as “Law of incentives to develop renewable energy projects” (Law 52-2003) followed on 2006 by the regulatory framework.

The geothermal energy as a renewable one, requires incentives to take off although the Government requires financial support to build, improve and strengthen infrastructure. In order to consider the social impact that the renewable sources of energy have on the population, a communication strategy is developing in order to:

- Inform and make conscious in the population about the renewable energy sources and the need of its use to have electric energy at low price.
- The utilization of indigenous geothermal energy resources is seen as preferable to purchasing foreign energy resources as coal, bunker, gas, oil.
- Compare price, dependence and contamination from other sources as fossil fuels
- Environmental benign and outline the social, environmental, economic and social issues in equity.

Although the law of incentives and its regulatory framework, the geothermal project investors are not defined, probably due to the risk and large cost of the exploration stage and high interest loans; at the same time the state external to be embarked in an external debt, must priorities according to the population needs centered on health, security and education as main goals for poverty eradication considering the infrastructure also a medium to reach the goal.

## **5. FUTURE DEVELOPMENT**

INDE's Board of Directors approved the Geothermal Resources Development and Profit Plan, including Amatitlán geothermal field as a concession to the private developer Ormat Ltd. and had signed a contract for 20 years, considering at first stage the installation of 22 MW by the end of 2006 and completing in the second stage 50 MW in five years.

The plan is to move the 5 MW backpressure turbine actually on line in Amatitlán to Zunil II geothermal field; the directional well drilled on 2005 on Zunil II had negative results so it will be necessary to drill at least two more production in the site.

At Tecuamburro geothermal field has been assigned funds to drill two wells and a cooperation application is on the way, as well as technical cooperation has been submitted to JICA. At the same time efforts have been done by the Plan Puebla Panama in order to apply for a soft government loan to JBIC for the development of Tecuamburro geothermal field, as an initiative to promote the geothermal energy.

Funds will be provided by Global Environmental Facility (GEF) by 2008 and INDE, for the drilling of exploratory wells to continue the feasibility studies and the plan is to start drilling next year with INDE's funds. Special concern should be taken in future geothermal development to get people acceptance to the project because it will affect the execution of it.

## **6. ABILITIES IN BUSINESS AND MARKETING SHOULD BE DONE TO IMPROVE THE UTILIZATION**

Through the years the use of geothermal energy has been dedicated in the rural areas for bathing, agriculture and some domestic uses; they are located mainly in the western part of the country (Totonicapán, Quetzaltenango) and its direct use has been done only in Amatitlán geothermal field by two private companies as well as have developed a tourism industry with thermal bath around Amatitlán lake.

BLOTECA was established about 20 years ago. It uses geothermal steam in the curing process of concrete products. It has an installed capacity of 1.60 MW and since 1998 is using an equivalent to 11.2 MW-hr year.

Agroindustrias La Laguna, a fruit dehydration plant that was set up as an experimental and demonstrational project. While developing this second project the owners decided to bring a new product, Eco-Fruit, which uses geothermal steam in the drying process. It has an installed capacity estimated 0.5 MW.

The geothermal resources could be well exploited although direct uses projects are smaller in scale than power generation, but the country benefit will be great because they create employment and industry, it could be seen as part of an strategic investor plan in each exploratory field stage, to develop direct as possible in order to use projects to create development.

## **7. TRAINING PROGRAMS**

Guatemala has had training and technical cooperation programs in the past for the personnel dedicated to the geothermal research. Although most of the personnel have been migrated to the private sector and the new generation need to improve technical capacity to reduce development risk as well to be competitive in the energy market.

To support the country efforts to promote the use of renewable energy there is a need to improve the human resources capability for the research, identification, evaluation, exploitation and maintenance of geothermal fields in Guatemala. It will be a desirable that as a region set up a geothermal cooperation net with energy agencies, utilities and universities responsible for finding, developing and operating geothermal energy resources.

## 8. CONCLUSIONS

### WHAT ARE THE LESSONS LEARNED?

1. The government took the risk of the initial exploration and investment, through soft loans from regional development banks or grants under bilateral assistance programs.
2. Concessions arrangements have been made with private developers in order to be productive.
3. Promotion of the renewable energy by law of incentives and campaign to increase participation and knowledge, in order to be socially acceptable.
4. Environment concerns and social issues.
5. Maximize the geothermal potential improving the feasibility studies of other geothermal fields.
6. Need to increase the renewable energy production due to its competitive low price to produce electricity and not depend on fossil fuels.
7. Create in each geothermal field a strategic plan to promote direct uses, such as people development and minimize investment cost.
8. Human resource capacity building for research and development in the geothermal process.

## REFERENCES

- Arnorsson, S., 1997. *Geochemical and Isotopic Reconnaissance Survey of the Totonicapán*
- Cepal Statistics Electric Sector 2005. Estadísticas sector eléctrico, 2005.
- Mérida Luis, Curing Blocks and Drying Fruit in Guatemala, G.H.C. Bulletin, 1,999
- OLADE-BRGM 1982. *Estudio de Reconocimiento de los Recursos Geotérmicos de Guatemala*
- Proceedings World Geothermal Congress 2005
- Antalya, Turkey, 24-29 April 2005